

Comparative Plant Ecology as a Tool for Integrating Across Scales

PREFACE

Ecology, like other sciences, can be divided into various subdisciplines: physiological ecology, population ecology, community ecology, evolutionary ecology, and so on. Although the boundaries between these subdisciplines are never strictly delimited, most ecologists would agree on the assignment of most studies to particular subdisciplines because the differentiating features of these subdisciplines refer to levels of biological organization (individuals, populations, communities) and types of research questions. Because these subdisciplines concentrate on different levels of biological organization, they tend to measure different variables and ask different questions and this makes it difficult to integrate our ecological knowledge across these different levels of organization. This potential ‘balkanization’ must be counterbalanced by integrating forces if sustained progress in ecology is to be maintained.

The subdiscipline of comparative plant ecology (or ‘functional plant ecology’ as a close cognate) seems different. Most plant ecologists would recognize the term as a valid subdiscipline of their science but it is less clear what differentiates it from other recognized subdisciplines. Comparative plant ecology is not restricted to a single level of biological organization; variables like maximum net photosynthetic rate (from physiological ecology), seed production (from population ecology), and species’ richness or rates of litter decomposition (from community and ecosystem ecology) can be found intermixed in the same paper. To me, comparative plant ecology is not defined so much by *what* phenomena it studies but rather by *how* it studies them. The unifying attributes of this subdiscipline seem to be (1) the use of functional traits (i.e. traits linked to evolutionary fitness and that determine the ability of a plant to survive, reproduce or disperse) as the explanatory variables; (2) the explicit comparison of these traits across many species in an attempt to elucidate general trends; and (3) the implicit or explicit comparison of different values of such traits across environmental gradients.

This promiscuous nature of comparative plant ecology seems to make it particularly suited for integrating across scales. It was with this potential in mind that I organized a half-day symposium during the 90th ESA/INTECOL Joint Annual Meeting, entitled ‘Comparative plant ecology as a tool for integrating across scales’. I asked five invited speakers to present their research in comparative plant ecology and, through their combined presentations, to explore the integrative potential of comparative plant ecology. The five papers in this Highlight section are the outcome of this attempt.

The first paper, by Garnier *et al.* (2007), illustrates the ability of comparative plant ecology to integrate across

scales. The spatial scale is large (Norway to Israel and Great Britain to the Czech Republic), as is the number of traits and the number of species. However, the most important result of the paper is to demonstrate how functional traits of individuals can be used to predict ecosystem responses to changes in land use.

Since a basic assumption of comparative plant ecology is that functional traits of individual plants, irrespective of their taxonomic name, can predict populational, community and ecosystem processes, then a key question must be: what functional traits are most important? Most studies concentrate almost exclusively on vascular plants and, of these, seed plants predominate. However, non-vascular plants form an important component of the vegetation in some ecosystems and so the ability of comparative plant ecology to predict across scales is compromised unless we include traits that are relevant to such plants. The second paper, by Cornelissen *et al.* (2007), reviews the types of functional traits of cryptogams that are most relevant to biochemical cycling and points the way towards a more complete list of functional traits.

Pigliucci (2007) has recently revived the notion of ‘phenotypic space’ as a way of thinking about constraints between traits. As the strength of the correlations between traits increase, more and more of phenotype space becomes ‘empty’ as empirically observed phenotypes become concentrated within those sections of phenotype space that are physically, evolutionarily and ecologically viable. One of the most influential recent findings of comparative plant ecology (Whitfield, 2006) is that many morphological, chemical and physiological traits of leaves are tightly correlated into a narrow region of phenotype space and thus defines a ‘worldwide leaf economics spectrum’ (Wright *et al.* 2004). The third paper of this Highlight set, by Wright *et al.* (2007), reports a search for other such ecologically ‘spectra’ involving six traits beyond those relating to leaves measured from 2134 different woody species from the neotropics.

Because of the integrative nature of comparative plant ecology, generality is emphasized. However, the relative advantage of a trait, or combinations of traits, is always contingent on the selective forces of the environment. A good example of this is the scale/precision hypothesis of Campbell *et al.* (1991), who proposed that dominant and subordinate herbaceous species would differ in the scale and precision with which they could modify their root and shoot systems in the face of resource supplies that are patchy in time or space. A key part of this hypothesis was that advantages in traits related to scale/precision would only occur in environments in which the vigour of potential

dominants was restricted by intermittent removal of biomass. The fourth paper (Grime, 2007) reviews this hypothesis and the empirical evidence and points out the confusion that can occur if such hypotheses are divorced from the appropriate environmental context.

Most research in comparative plant ecology is empirical. However, if functional traits determine how plants interact with their environment, and if such trait–environment interactions affect populational, community and ecosystem processes, then it should be possible to develop theoretical models that describe this cascade based on simple rules. The final paper (Hunt and Colasanti, 2007) evaluates this possibility by reviewing a type of model in which plants are conceived to be simply self-assembling modules that grow and die based on very simple rules derived from trait-based comparative plant ecology. Surprisingly, such simple rules can generate many of the most ubiquitous patterns typical of populational and community ecology.

Ecology has always been torn by the trade-off between the desire to seek generality and the need to accurately describe reality. This is a healthy tension only if we also strive for integration. Together, this collection of papers both emphasizes the ability of comparative plant ecology to integrate across scales and points the way to new and exciting possibilities to construct a more synthetic plant ecology.

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